U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Outside-the-Box Options to Advance Multifamily Building Efficiency

National Energy Codes Conference Seminar Series

Building Technologies Office

Fall 2022

NECC Seminar Series Lineup

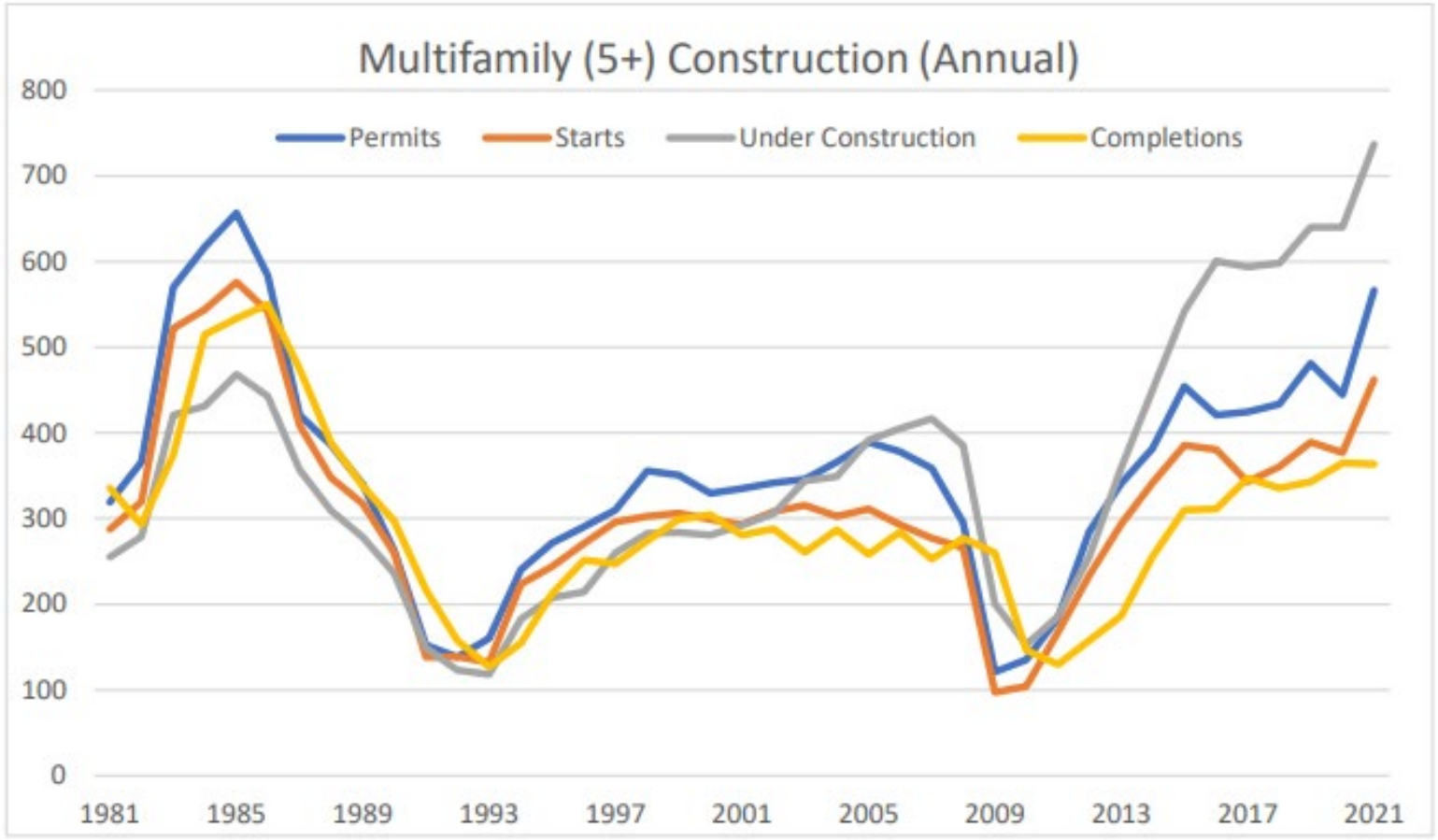
Catch the entire lineup of sessions bi-weekly—Thursdays @ 1p ET:

- 8/18: Taking Charge of Climate Change through Stretch Codes
- 9/8: Energy Codes and Utility Programs: The Peanut Butter & Jelly of Energy Efficiency
- 9/22: Energy Code Implementation: Insights from the Field to the Classroom
- 10/6: Less is more: Building to Zero Energy, Water and Carbon
- 10/20: Cracking the Code: Unlocking the Benefits of Off-site Construction
- **11/17: Outside-the-Box Options to Advance Multifamily Building Efficiency**

> Learn more: https://www.energycodes.gov/2022-summer-seminar-series

Building Energy Codes
U.S. DEPARTMENT OF ENERGY

Multifamily: Why it Matters



Source: U.S. Census Bureau, New Residential Construction.

Agenda

- Intro
- HPWHs in Multi-Family Buildings
  - Questions
- Multifamily All in One Code (WA case study)
  - Questions
- Additional Q&A
- Closing

Heat Pump Water Heaters in Multi-Family Buildings

DOE Codes Webinar

November 2022

Robb Aldrich, raldrich@swinter.com

Since 1972, Steven Winter Associates, Inc. has been providing research, consulting, and advisory services to improve the built environment for private and public sector clients.

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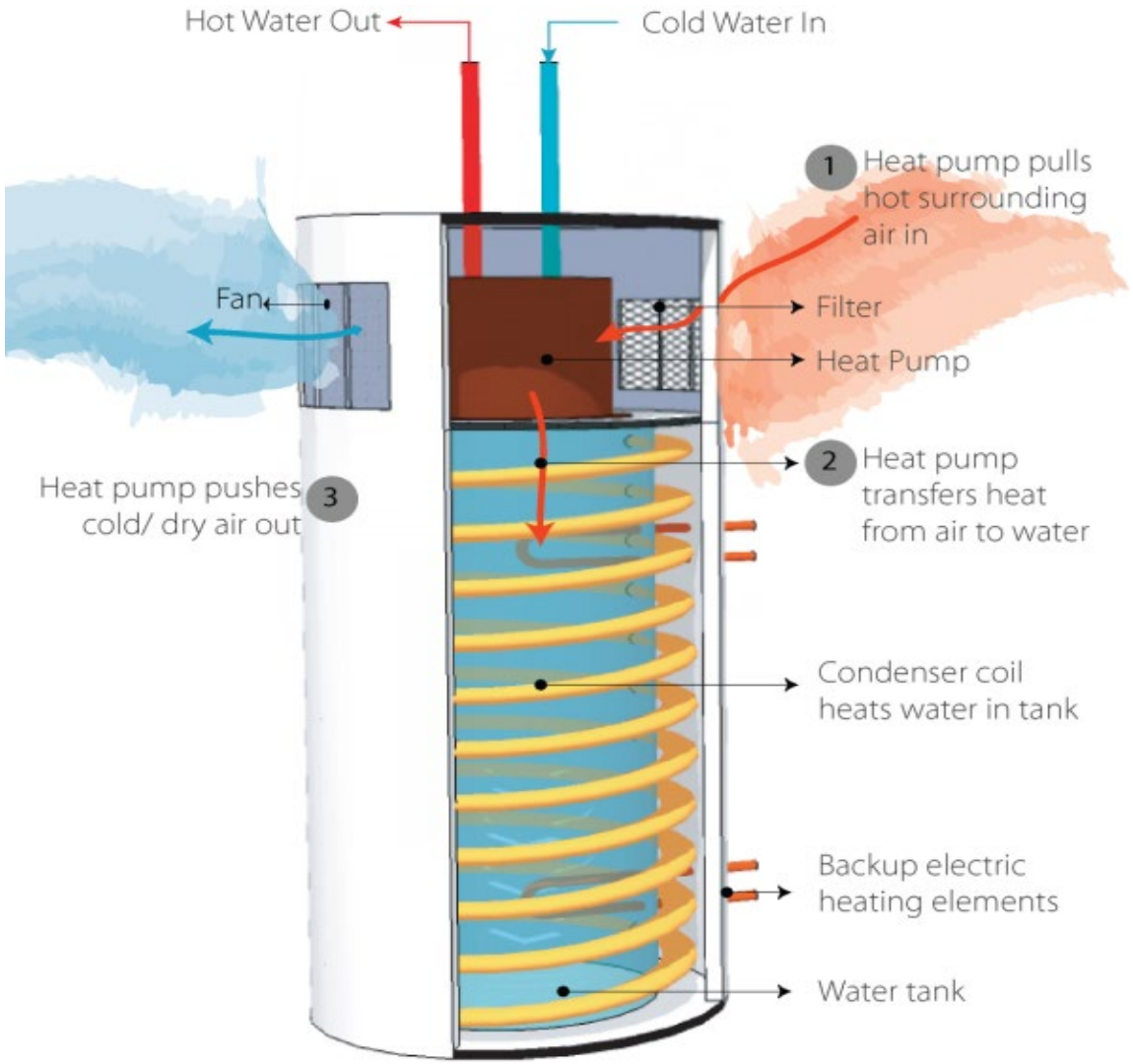
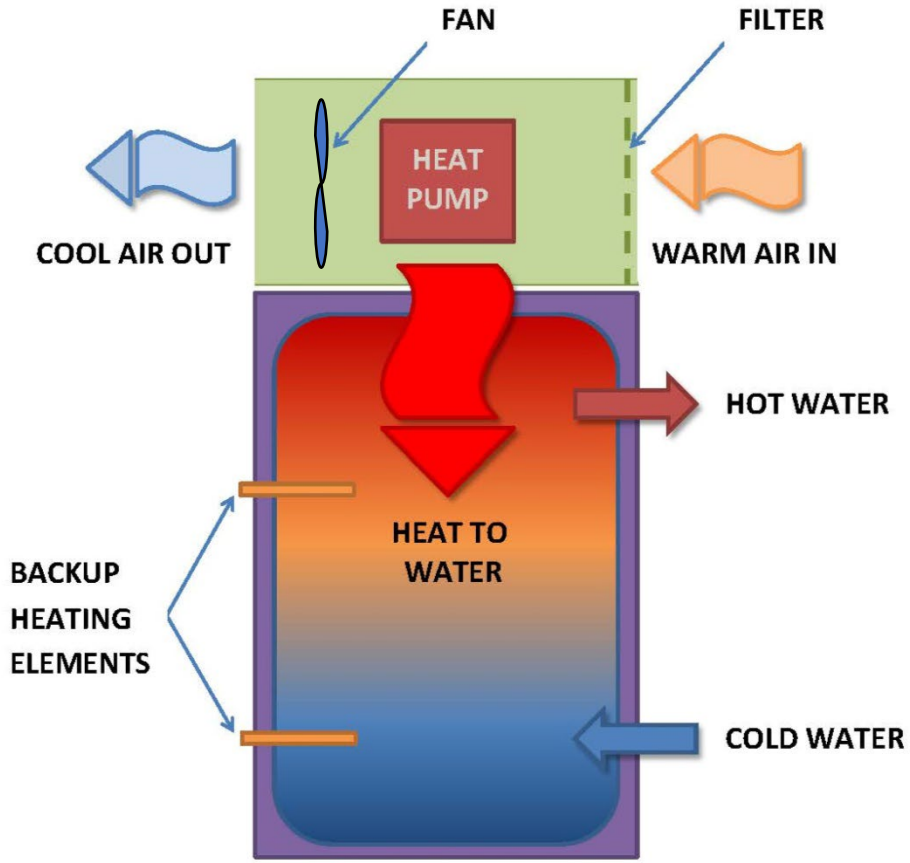
Heat Pump Water Heaters



How do they Work?

- Moves heat from surrounding air into water
- HP Cap: 5,000 – 10,000 Btu/h
- Cools & dehumidifies the surrounding air



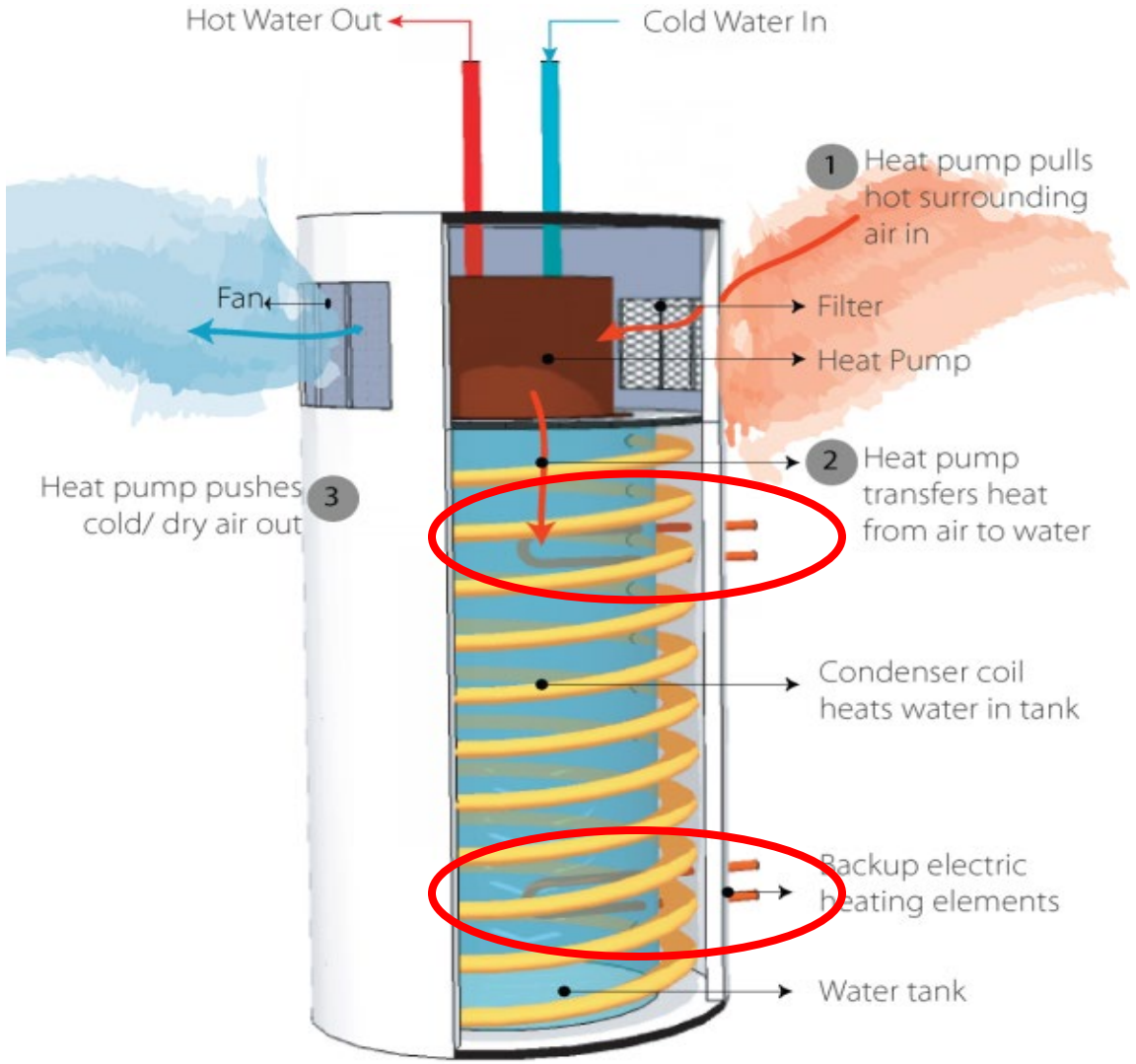
Integrated HPWHs REMOVE HEAT from incoming air and TRANSFER that heat to the water.

Air leaving the HPWH is **~20°F COLDER** (~200 cfm)

Small **window AC**
Running 5-6 h/day

Keys to Efficiency

- Minimize **Resistance**
- **BIGGER** tank
- **HOTTER** water
  - scald protection
- **Warmer** intake air
  - min 40-50°F (134a)
  - warmer better
- Use less hot water!



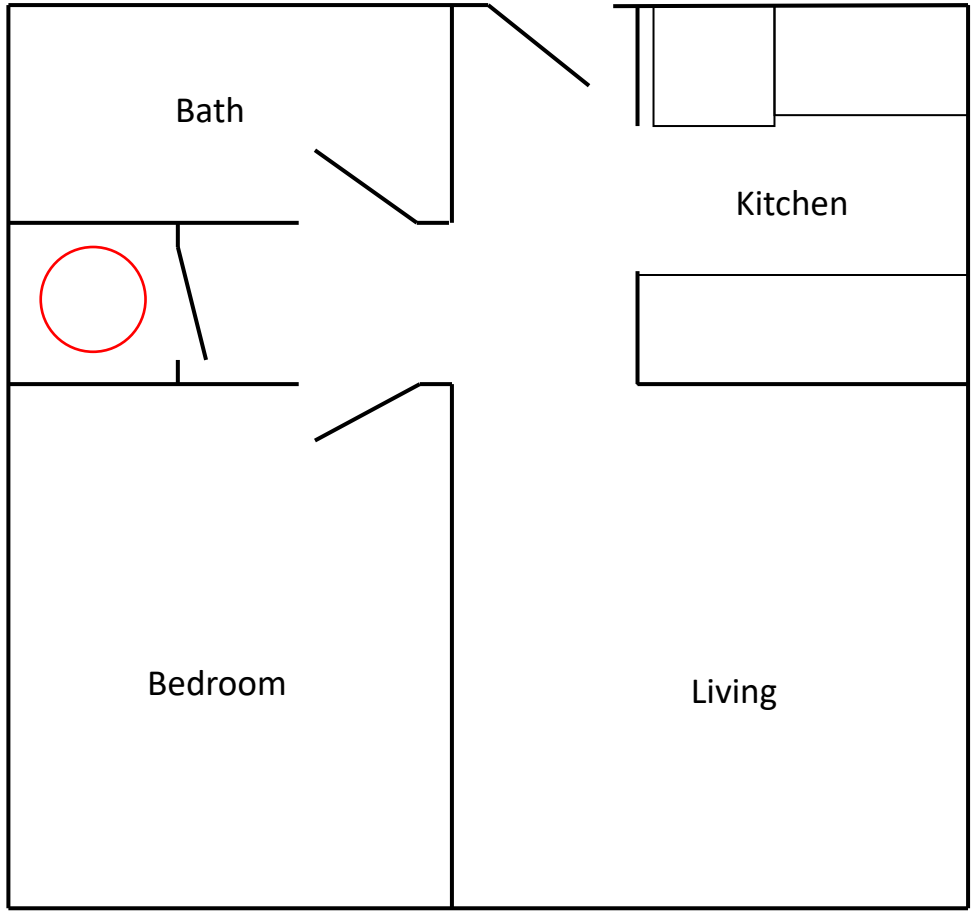
Good Applications

SF Homes

- Many basements

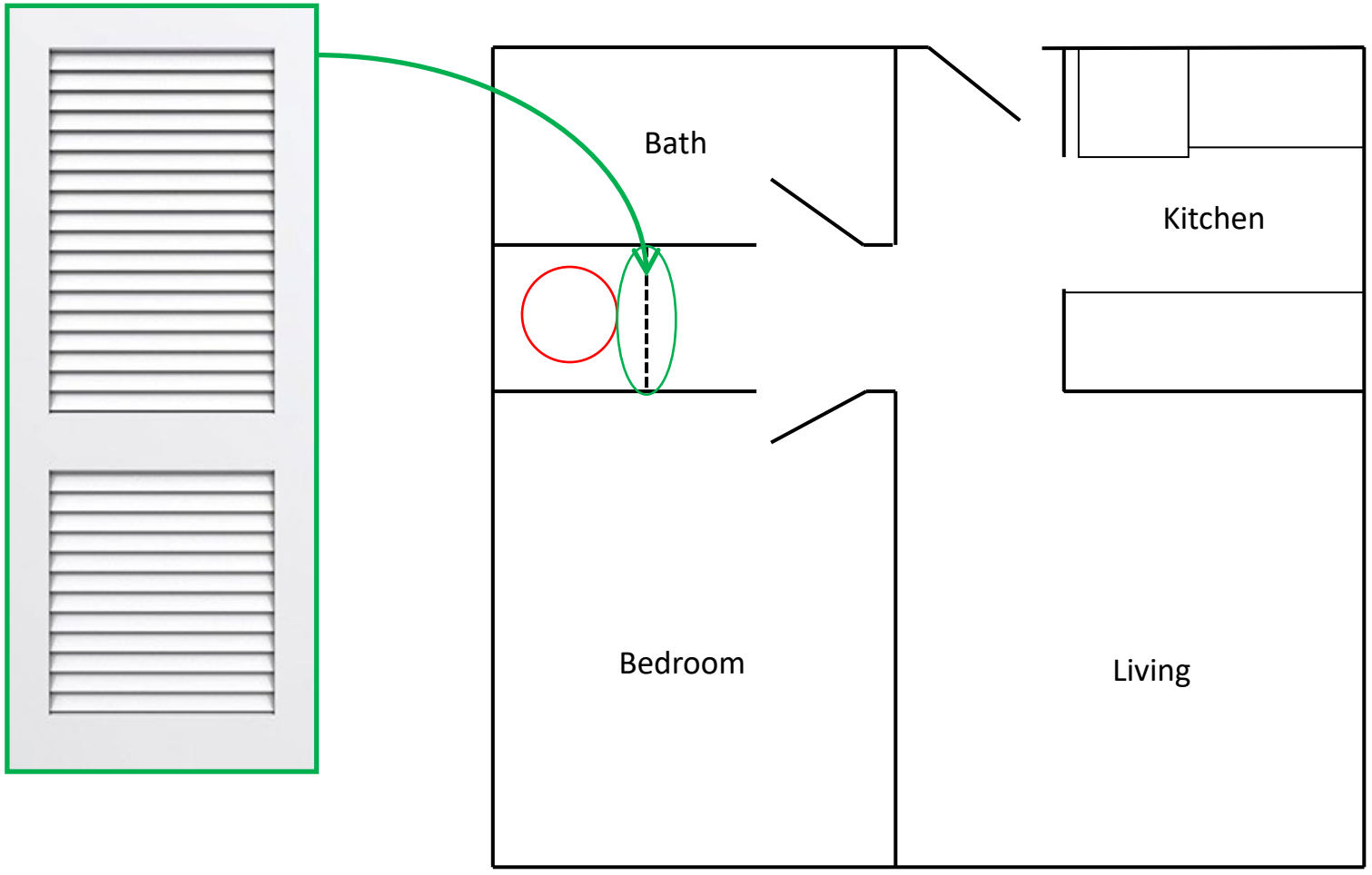
- Many garages in non-freezing climates

No Basement...?



Do not do this.

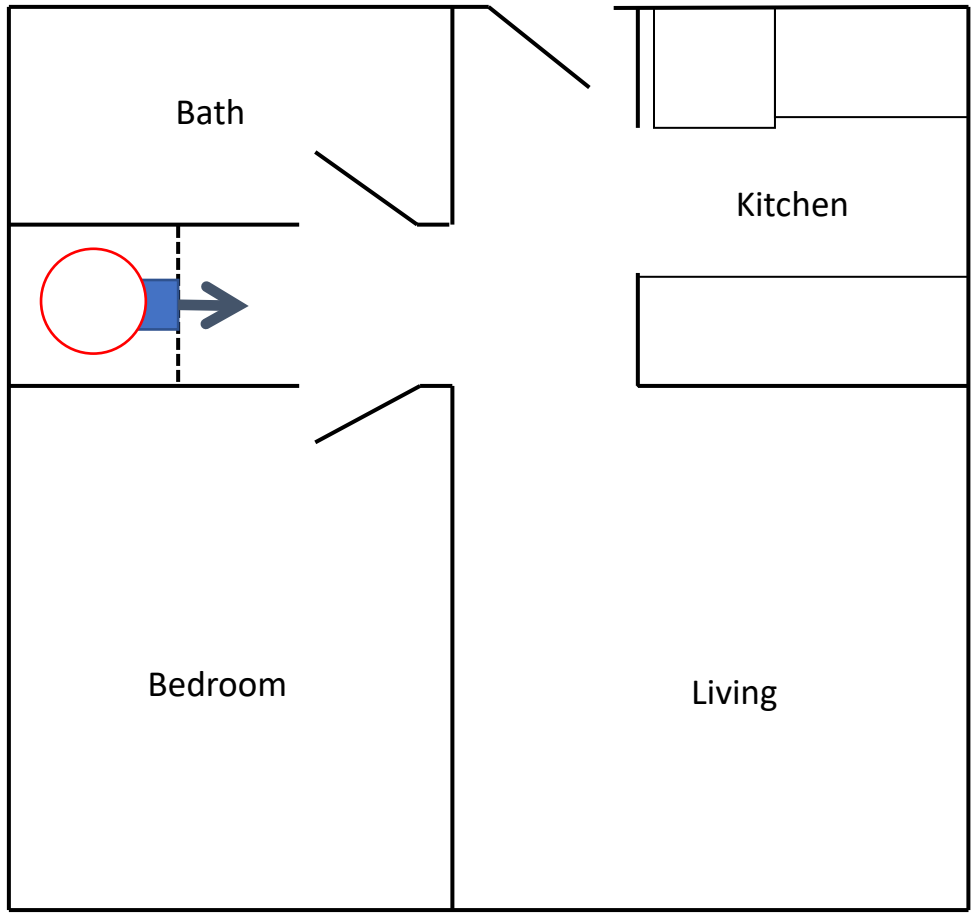
Do louvered doors work?



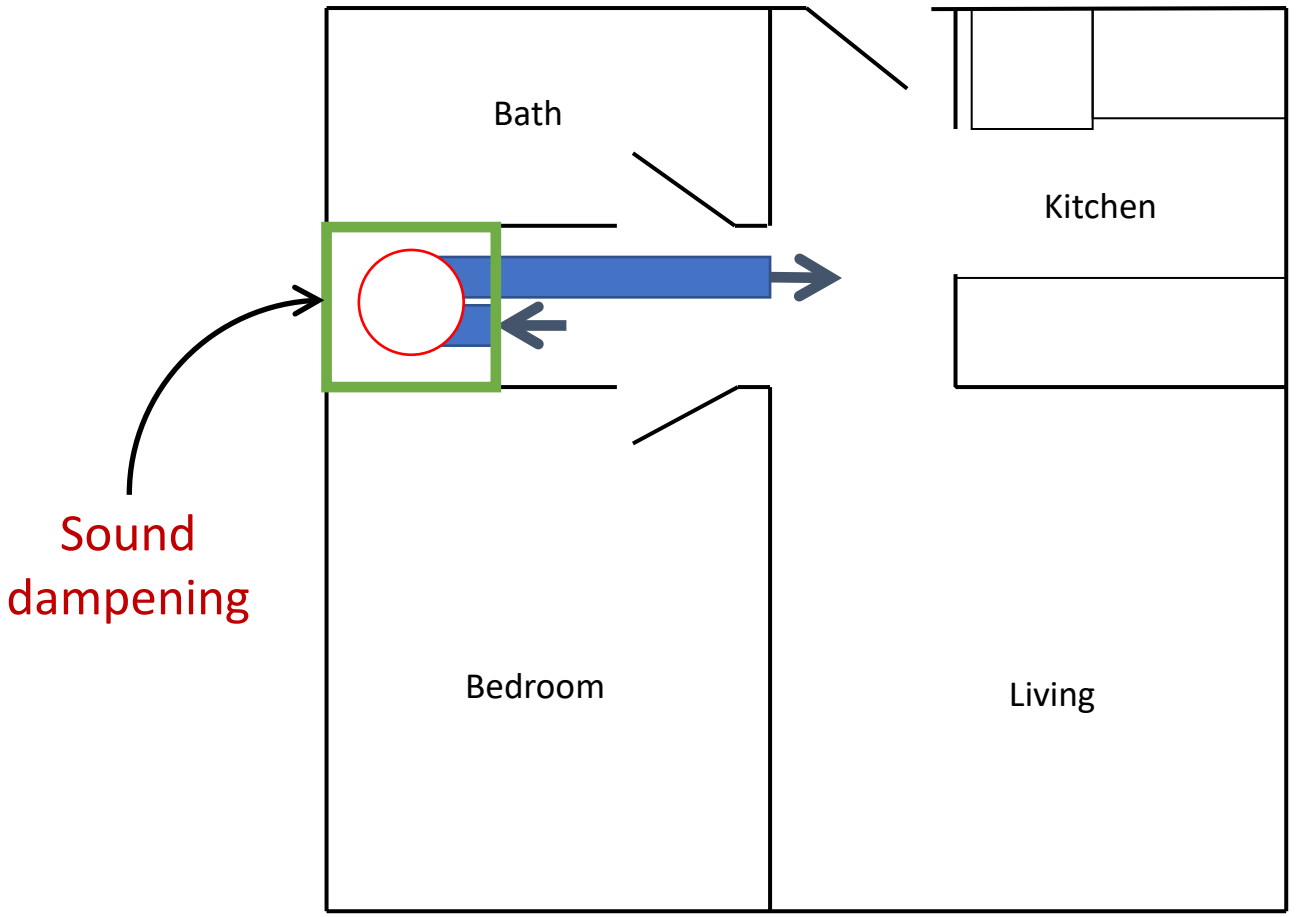
Closets

- AHU and HPWH in apartment closet with louvered door
- Sound pressure in living space with door closed: 53 dBA
- “Quiet Mode”

Ducting?

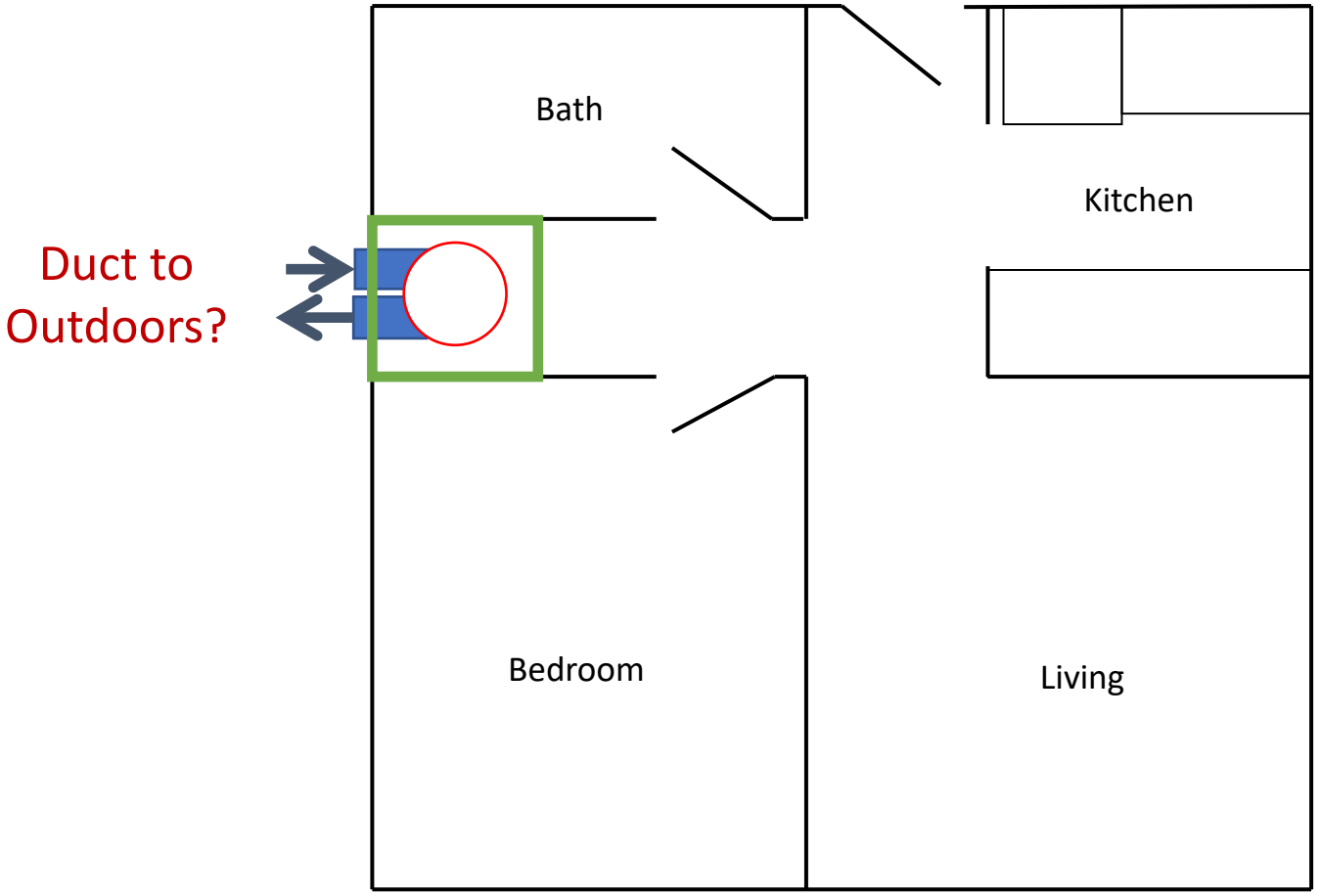


Ducting?

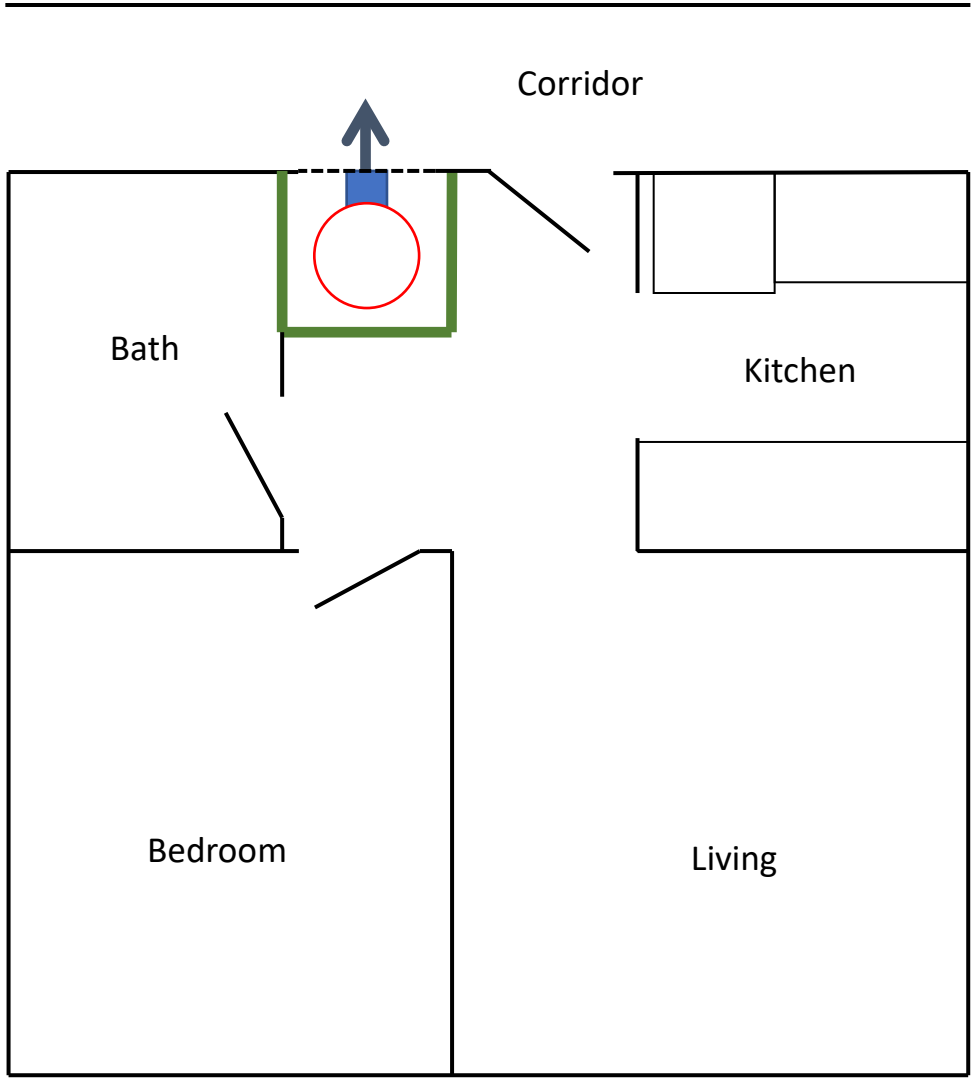


Apartment Closets?

Ducting to Outdoors?



Duct to Corridor?



Central Mechanical Room

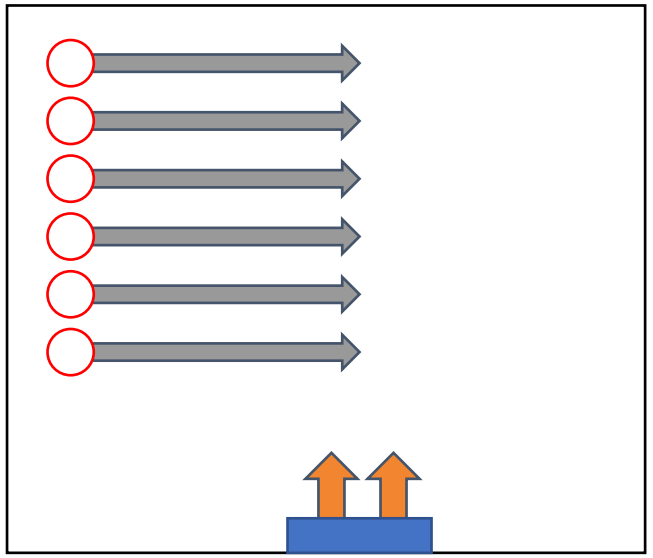
Remote, Integrated HPWHs

Remote, Integrated HPWHs

Central Plants are Possible, but...

- Prevent short-circuiting
  - Spacing
  - Ducting

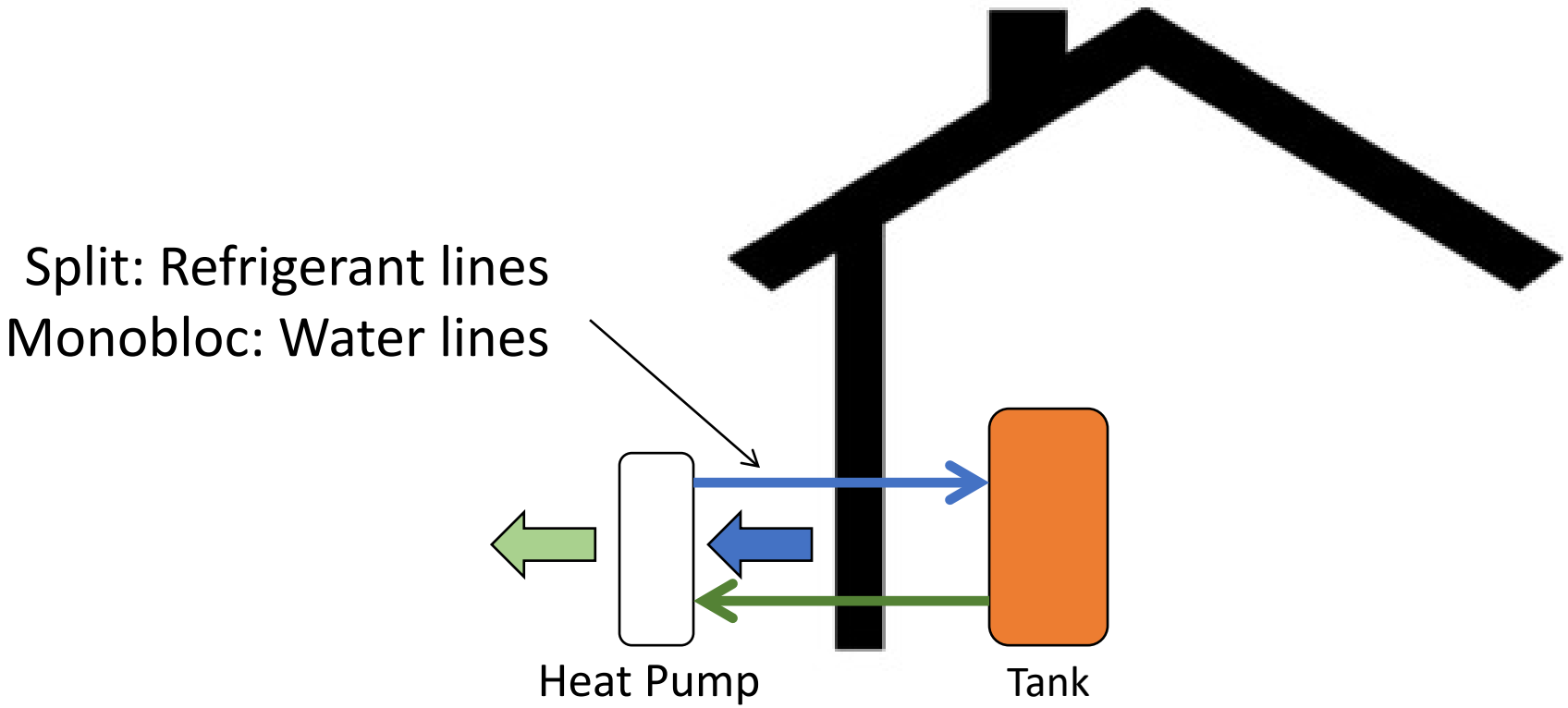
- HEAT will be needed in the space!
  - outdoor air (2-3 seasons)?
  - mini-split heat pump?
  - somewhere else in the building?
  - NOT resistance!



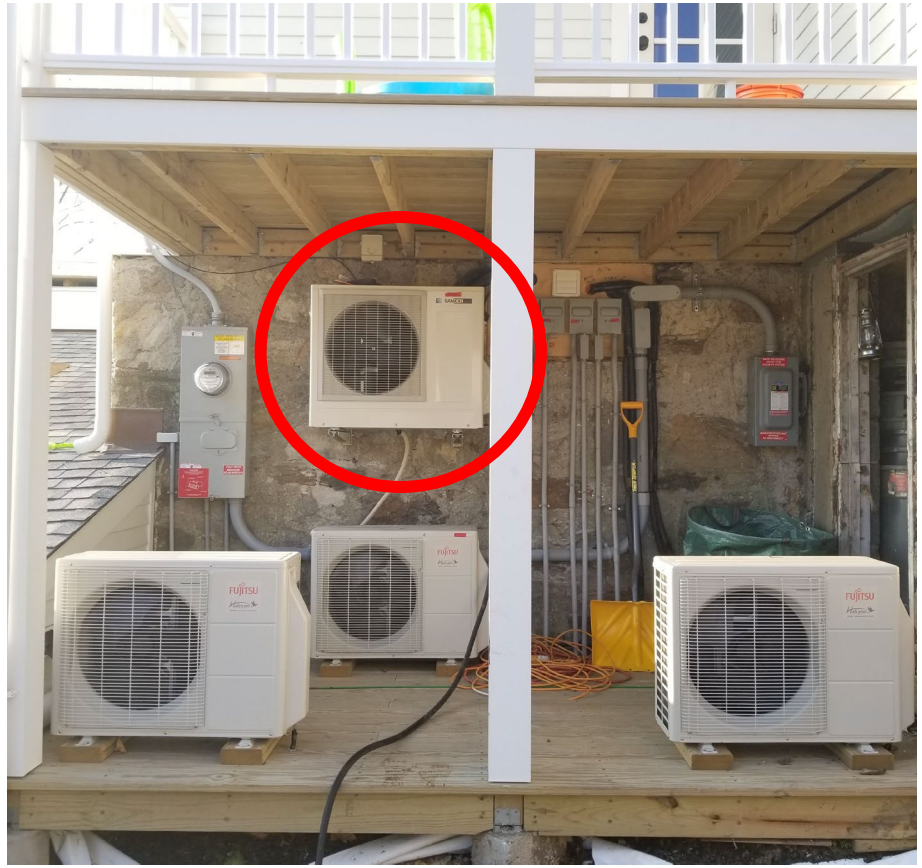
Eversource Guidelines

https://energizect.com/sites/default/files/documents/RNC%20-%202022%20HPWH%20Guidelines.pdf

Split (or Monobloc) systems

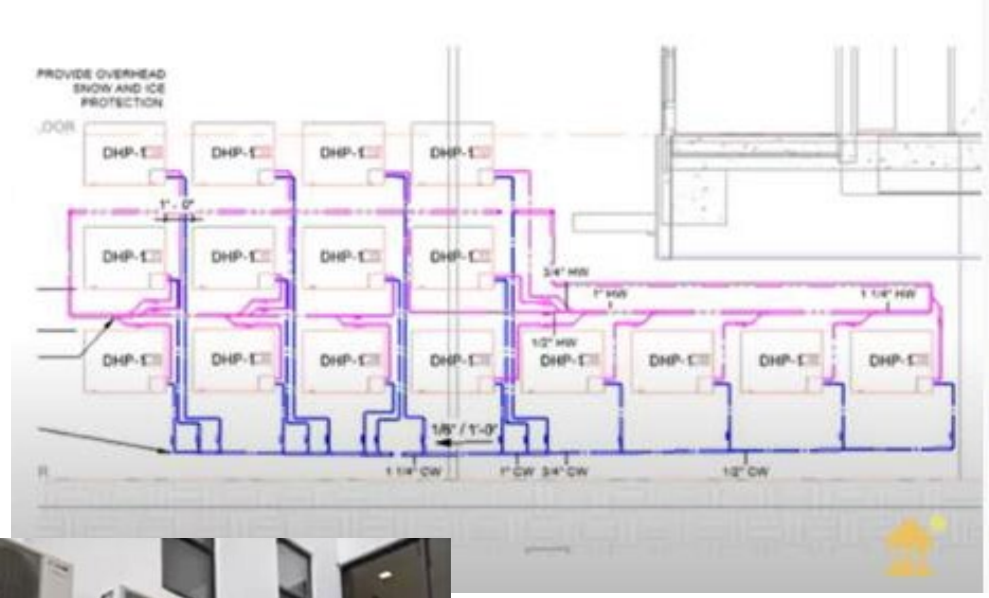


Split system



Upstate NY Project (Ithaca, NY)

- MEP: Taitem Engineering
- Multifamily
- Operational
- DHW heaters: Sanden SANCO2 (plant-style) w/ electric resistance backup



Webinar available:
https://www.youtube.com/watch?v=k39Ob2hTtl8

Hotel Marcel (New Haven, CT)

Cooper Park Commons & La Central (NYC)

- New Construction
- Affordable multifamily
- Construction anticipated 2023
- DHW: central CO_2 plants

Vital Brooklyn Alafia (NYC)

- New Construction
- Affordable multifamily, 561 units
- Construction anticipated 2023
- DWH: Water source HP w/ wastewater heat recovery

Northland Newton (Newton, MA)
Electric Resistance Tanks

- New construction multifamily – 750+ units
- In design
- DHW: Electric Resistance Tanks

HPWH too problematic...?

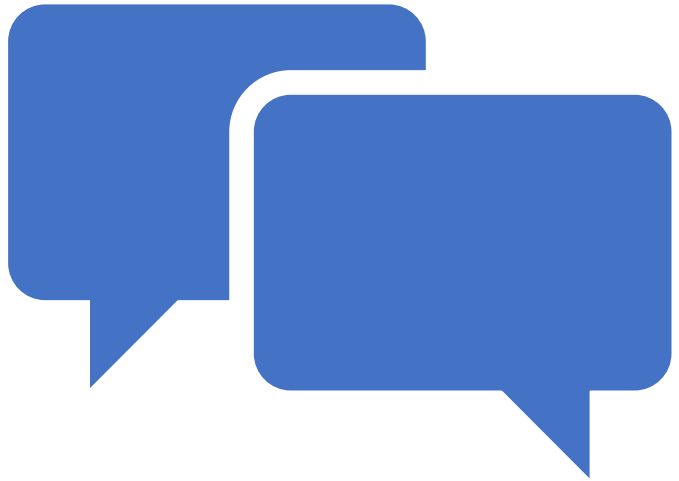
Resistance is better than screwed up HPWH!

- Lower the load
- Efficient appliances, fixtures
- Very well insulated tank
- Insulated plumbing, efficient distribution
- Heat traps

Keep tabs on new tech! More HP systems coming.

Thank you!

Questions?



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Multifamily All in One Code

Seattle Department of Construction & Inspections

Duane Jonlin, FAIA

November 2022

The division was weird to begin with

- From earliest days of ASHRAE 90.1
- 3-story apartment building complies with IBC, not IRC. (Thus, also has to comply with IFC, IMC, etc.) Was it:
  - Similar surface to floor area ratio?
  - Height for ladder truck rescue?
  - Homebuilder vs. general contractor turf?
- Development with 3-story *and* 4-story units used same building code for all, but separate energy codes
  - Also, 3-story motel vs. 3-story apartment

Just redefine “Residential Building”

RESIDENTIAL BUILDING. For this code, ((~~includes~~)) the following building types <u>are residential buildings</u>:

1. Detached one- and two-family dwellings.
2. Multiple single-family dwellings (townhouses).
3. ((~~and Group R-2,~~)) Group R-3 ((~~and R-4~~)) occupancy areas in buildings three stories or less in height above grade plane
4. Group R-2 buildings three stories or less in height above grade plane whose dwelling units are accessed directly from the exterior
4. Accessory structures ((~~thereto~~)) <u>to residential buildings</u>.

Exception for “woody walkups”

- “Garden-style” apartments can choose either the residential or commercial code
  - Exterior entrances to each unit

R401.1 Scope. This chapter applies to residential buildings. Group R-2 occupancy areas with dwelling units accessed from enclosed interior corridors or other enclosed interior spaces must comply with the Washington State Energy Code (WSEC), Commercial Provisions. Other Group R-2 occupancy areas **are permitted to** comply with the WSEC, Commercial Provisions, in lieu of the WSEC, Residential Provisions.

Water heater blues

- Last-minute compromises don’t always yield good code language
- Exception: Low-rise multifamily can use residential energy code requirements for in-unit water heaters
- But, new residential code requirement for heat pump water heaters says it only applies to single family and townhouse
  - Heat pump exemption for dwelling units smaller than 1000 sf
  - Another exemption for small (<20 gal) tank units

Envelope Comparison
(Commercial somewhat more restrictive)

Residential Code U-factors

- U-0.024 Above roof deck
- U-0.024 Attic
- U-0.056 Wood framed walls
- U-0.029 Floor
- F-0.59 Slab on grade (2’ depth)
- U-0.30 Windows

Commercial Code U-factors

- U-0.027 Above roof deck
- U-0.021 Attic
- U-0.051 Wood framed walls
- U-0.029 Floor (framed)
- F-0.54 Slab on grade
- U-0.26 Windows

Commercial code options: How to get to 41 pts

#20: 42 credits Hot water distribution right-sizing using plumbing code Appendix M
(*reduces* construction cost due to smaller pipe sizes, insulation thickness, and circulation pump size)

(Another credit package – those in **bold** below equal 41 credits, total $0.68/sf)

- #28: 19 credits Residential dishwasher & fridge with Energy Star "Most Efficient" label
- #07: 31 credits High performance DOAS
- **#14: 20 credits Renewable energy** ($0.37/sf @ $2.50/W)
- #21: 13 credits Hot water temp maintenance
- #25: 24 credits Reduced air leakage
- **#09: 4 credits 10% lighting power reduction** ($0.18/sf - PNNL)
- **#11: 6 credits: High-efficacy lamps** (no additional cost)
- **#12: 8 credits main lighting switch for whole unit** ($0.13/sf - PNNL)
- **#23: 3 credits low-flow shower heads** (no additional cost)
- #29: 6 credits Energy Star "most efficient" label washer & dryer

Total of items in bold**: 41 credits, $0.68/sf = $558 for 820 sf.**

Residential code options: How to get to 6.5 pts

Options table costs for R-2 in the RESIDENTIAL energy code. For residential, the TAG has recently approved the NEEA/Ecotope package of R406 changes (21-GP2-073). The required 6.5 credits could be provided for an R-2 multifamily building by any of several sets of options. One group is shown below with heat pump heating. These appear to be the least expensive packages available for multifamily, and the cost for either package is clearly higher than the cost for meeting the commercial code options.

Residential code credit package, with DHP

- Credit 1.4: 1.0 credit for U-0.20 glazing ($887)
- Credit 2.2: 1.0 credit for 1.5 ACH HRV ($2034)
- Credit 3.4: 2.0 credits for Ductless Heat Pump ($3060)
- Credit 5.4: 2.5 credits for Tier III HPWH ($318)

Total: 6.5 credits, $6,299

There's more to life than energy efficiency

Don't compromise human values

Health (sunlight, clean air & water)

Comfort (temperature, humidity)

Environment (pollution, carbon emissions)

Durability (long-lasting materials & equip)

Quiet (machinery, traffic)

Beauty

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Res vs. Com Efficiency Analysis for WA LRMF

- **Question**: would LRMF projects in WA consume more energy if built to the commercial code instead of the residential code?

- **Methodology**: model two prototypes under current WA code
  - 3-story, 26,400 ft^2 “double-loaded corridor”
  - 2-story, 7,616 ft^2 “woody walk-up”

- **Energy Credit Assumption**: analyzed two different scenarios for each code
  - HPWH emphasis
  - Envelope emphasis

Modeling Inputs & Assumptions

	Woody Walk-Up	Double Loaded Corridor
Total Area	7,616 ft²	26,400 ft²
Floors	2	3
Fenestration %	18%	34%
Residential Space %	88%	87%
Corridor Space %	N/A	9%
Office/Amenity Spaces (Gym, Lounge, etc.) %	13%	4%

Optional Measures	From Table R406.3 – 4.5 Credits required	From Table C406.1 – 6 credits required
Package #1: HPWH Emphasis	1.2 Windows = U-0.20 (1 Credit) 2.2: 2 ACH50, 65% HRV (1.5 Credits) 5.6: Tier III HPWH (3 Credits) R406.2.3: ER Heat (-1 Credit)	C406.9: HPWH w/ min. COP of 3.0 (8 Credits)
Package #2: Envelope Emphasis	7.1: Energy Star Appliances (1.5 Credits) 3.4: Ductless Heat Pumps, HSPF≥10 (2 Credits) 1.4: Windows = U-0.25; (1 Credit) Wall = U-0.045; Floor = U-0.025; Slab = F-0.36;	C406.10: Max 85% of permitted UA (6 Credits)

Component	2018 WSEC-R Model	2018 WSEC-C Model
Building Thermal Envelope		
Above Grade Wall	2x6 int. R-21 → U-0.056	2x8 std. R-25 → U-0.051
Glazing	U-0.30, SHGC-N/A	U-0.30; SHGC (PF<2) - 0.38 (S,E,W); 0.51 (N)
Roof (Flat Ceiling)	R-49 → U-0.026	R-49 → U-0.021
Floor Over Unheated	R-30 → U-0.029	R-30 → U-0.029
Slab-on-Grade	R-10 for 2ft → F-0.54	R-10 for 2ft → F-0.54
Infiltration	5 ACH50	0.40 cfm/ft²
Building Systems		
Heating ~~& Cooling~~	ER Heat: η = 1.0	ER Heat: η = 1.0
Ventilation	ERV – 1.0 cfm/W, 60% Sensible HR Schedule: Cycle 24 hr/day	ERV – 1.2 cfm/W, 60% Sensible HR; Schedule: Cycle 24 hr/day
DHW System	Elec. Resistance: η = 0.95	Elec. Resistance: η = 0.95
Hot Water Consumption	Q_{DHW} (kWh/yr) = 570+1034(#occ) Add: 10% reduction for low-flow showerheads	Q_{DHW} (kWh/yr) = 570+1034(#occ) Add: 10% reduction for low-flow showerheads
Thermal Loads		
Lighting Loads/Gains	90% high efficacy (LED fixtures at 65 lumen/W) (Assuming 0.44 W/ft² – Double Loaded Corr.) (Assuming 0.42 W/ft² – Woody Walk Up)	Common areas - 0.41 W/ft²; Dwelling Units - Unregulated (Assuming 0.44 W/ft² – Double Loaded Corr.) (Assuming 0.42 W/ft² – Woody Walk-up)
Equipment Loads/Gains	Unregulated (assuming 0.75 W/ft²)	Unregulated (assuming 0.75 W/ft²)
Occupancy Loads/Gains	Occupant Density - 250 ft²/person Occupancy Gains – 250 Btu/h (Sensible), 200 Btu/h (Latent)	Occupant Density - 250 ft²/person Occupancy Gains – 250 Btu/h (Sensible), 200 Btu/h (Latent)

Results

- Baseline (pre-credits): Com more efficient
- With credit selections:
  - Double Loaded Corridor: Res ≈ Com
  - Woody Walk-up: Res more efficient

Double Loaded Corridor - EUI (kBtu/sf/yr)

	WSEC-R Baseline	R406 Package #1	R406 Package #2	WSEC-C Baseline	C406 Package #1	C406 Package #2
PLUG LOADS	7.3	7.3	7.3	7.3	7.3	7.3
INTERIOR LIGHTS	4.8	4.8	4.8	4.6	4.6	4.6
SPACE HEATING	5.4	3.7	2.0	4.3	4.3	3.6
SPACE COOLING	0.0	0.0	1.4	0.0	0.0	0.0
HEAT REJECTION	0.0	0.0	0.1	0.0	0.0	0.0
FANS	2.7	2.7	2.7	2.3	2.3	3.2
DOMESTIC HOT WATER	6.8	3.3	6.8	6.8	3.3	6.8
EUI	**27**	**22**	**25**	**25**	**22**	**25**

Woody Walk-up - EUI (kBtu/sf/yr)

	WSEC-R Baseline	R406 Package #1	R406 Package #2	WSEC-C Baseline	C406 Package #1	C406 Package #2
PLUG LOADS	8.0	8.0	8.0	8.0	8.0	8.0
INTERIOR LIGHTS	5.2	5.2	5.2	4.9	4.9	4.9
SPACE HEATING	8.3	5.2	2.3	7.2	6.9	6.3
SPACE COOLING	0.0	0.0	0.6	0.0	0.0	0.0
HEAT REJECTION	0.0	0.0	0.04	0.0	0.0	0.0
FANS	3.8	2.8	4.0	2.4	3.3	3.3
DOMESTIC HOT WATER	7.3	3.6	7.3	7.3	3.6	7.3
EUI	**33**	**25**	**27**	**30**	**27**	**30**

Outcomes / Takeaways

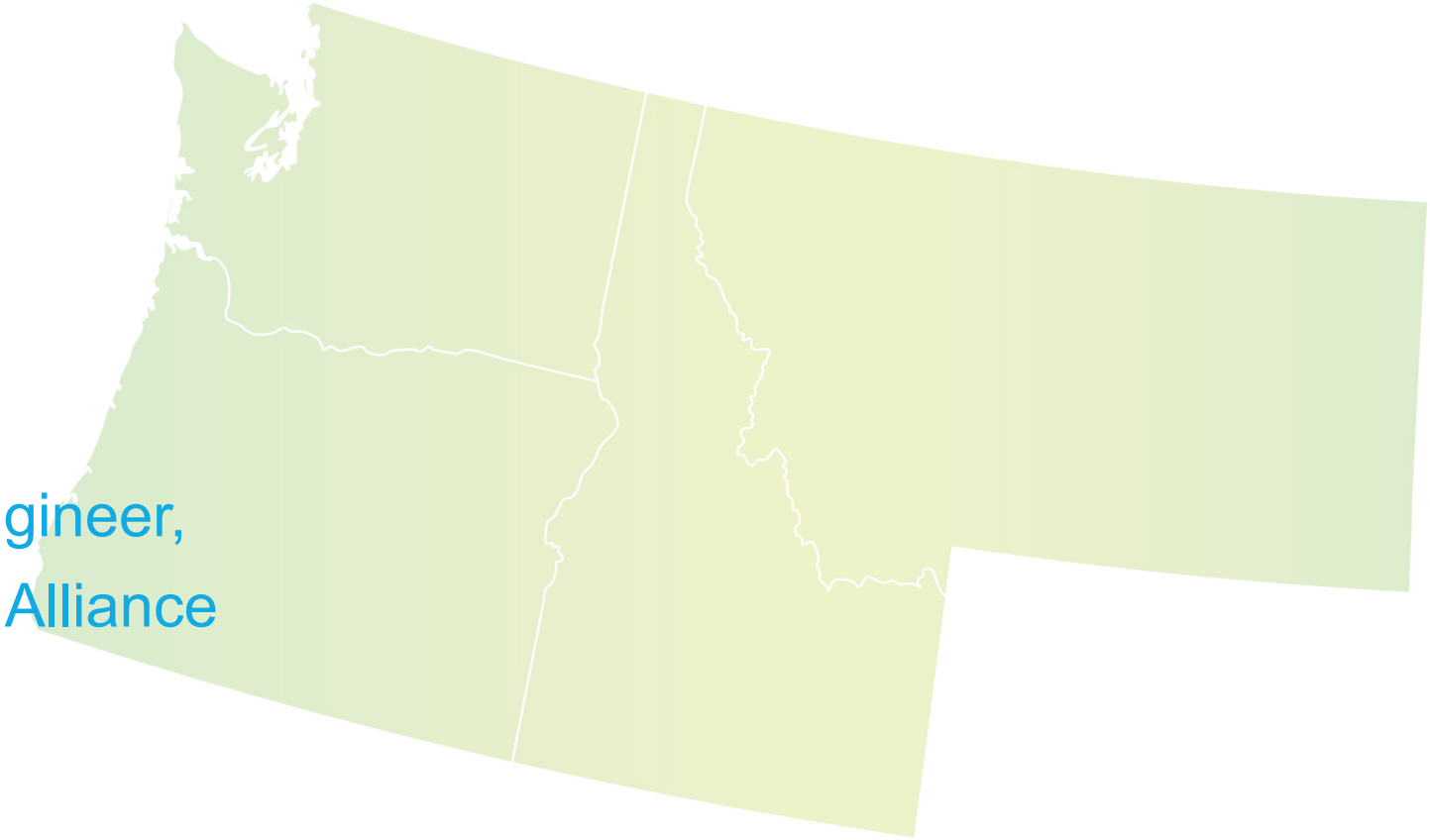
- LRMF in WA
  - Units accessed via internal spaces (e.g., corridor buildings) are moving to commercial code in next code version (2021 WSEC).

- Beyond WA
  - WA codes differ significantly from IECC, but this methodology could be replicated by interested AHJs.

Kevin Rose

Lead Codes & Standards Engineer,

Northwest Energy Efficiency Alliance



Q & A

Thank You!

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